Wake Forest School of Medicine

Institute for Regenerative Medicine

WFIRM Summer Scholars Program 2015 – Scholars' Blog

Summer Scholars 2015 Profiles

Mark Bartel
North Carolina State University, Biomedical & Electrical Engineering

I am a rising junior at North Carolina State University (NCSU) pursuing a degree in biomedical engineering. Aside from low key, occasional biomechanical research projects at NCSU, this is my first major research endeavor. I was born in Toronto, Canada, but my family has lived in Raleigh, North Carolina, for most of my life. My long-term goal is been to acquire an MD and become a surgeon - I wish to travel to foreign nations for half of the year with *Doctors Without Borders*, using the skillsets acquired from an engineering background to improvise, repair, and improve hospital technology wherever possible. The biggest issue with medical equipment is not the lack thereof – it is what to do with it when it malfunctions. Donations are plentiful, but maintenance instructions are rarely, if ever, in the native tongue, so nurses and physicians are forced to go without the device when it breaks, even if repairs are simple and straightforward.

For the 2015 Summer Scholars Program, I will be working under the auspices of Dr. John Jackson on a project involving the regeneration of inner ear hair cells. The hair cells in the ear are located in two parts of the ear – the kinesthetic vestibular system and the cochlea - with functions for balance and hearing, respectively. There are two types of cells under scrutiny for this project – supporting cells and hair cells. Destruction of the hair cells results in balance, coordination, and hearing issues. Currently, over 250 million people worldwide suffer from the debilitating effects resulting from the loss of these cells, and it is one of the largest problems faced by returning veterans. Both fish and amphibians can regenerate these cells, but mammals cannot – the hair cells exist in a post-mitotic state, hampering division. Researchers have found induced proliferation of the cells in mice can be attributed to the activities of the c-myc gene – an oncogene found in tumors and cancer cells. This provides some unique challenges, because the vast majority of research involving the c-myc gene has been focused on how to suppress it.

One method that has shown some potential is the use of a retrovirus to insert the gene into the supporting cells of the inner ear. This causes the desired proliferation, but unfortunately, the insertion of an oncogene into human beings will simply never be passed by the FDA, so another method must be found. A second method involves using a transcription molecule to bind to the promoter region of the c-myc gene. The best molecule so far is called BIO. Unfortunately, it is not ideal – it is part of a biochemical pathway known as WNT, where it functions as a GSK3 inhibitor, thus preventing the degradation of β-catenin, which can then go into the nucleus and facilitate the expression of the c-myc gene. Researchers believe that BIO is part of multiple other pathways, largely due to the lackluster amount of signals received from the volume of the molecule administered in vivo. In essence, my goal is to help find a molecule that can function as a novel c-myc activator in substitution of BIO that can induce both proliferation of supporter cells and transformation of some of those supporter cells into the hair cells needed to restore hearing and balance. This will be done through the use of a novel luminescence assay. Cells that have undergone mitosis and divided as necessary can then be marked with a staining technique that employs a marker called edU. If successful, then the molecule can undergo further testing in vivo to determine if the results are as promising in a live biological specimen as they are with cells in vitro.

Amanda Paraluppi Bueno
University of Idaho, Biomedical Sciences

My name is Amanda Paraluppi Bueno and I am pursuing my Bachelor's degree in Biomedical Science at the Centro Universitario Heminio Ometto, Araras-SP (Brazil). I came as an exchange student to study at University of Idaho for one year through the program, *Science without Borders*. This summer I am provided a unique opportunity to do what I love -- research in the field of regenerative medicine. I am very excited as through my summer research experience at the Wake Forest Institute for Regenerative Medicine (WFIRM), I will be able to learn about and contribute to both the promising field of regenerative medicine to include emphasis on aging-related research.

Prior to my summer research at WFIRM, I participated in a research during my junior and senior year (Fall 2013 – Summer 2014) under Dr. Flávia C. M. C. Alves at Centro Universitário Hermínio Ometto, Araras, São Paulo (Brazil). The project was selected to be funded by the National Council of Scientific and Technological Development (CNPq) in Brazil. In this project, I had the experience of using a technology to incorporate growth factors in scaffolds to improve the healing process of chronic wounds in the skin that are common in some diseases like leprosy. This gave me the passion of doing research and helped me to decide to focus my studies on regenerative medicine.

During this summer my Principal Investigator is Dr. Graça Almeida-Porada and my mentors are Saloomeh Mokhtari and Steven Greenberg. Our goal is to develop novel cell-based therapies that could promise a curative treatment for Inflammatory Bowel Disease (IBD). IBD includes a group of chronic inflammatory illnesses of the gastro-intestinal tract, the most common forms of which are Crohn's disease and ulcerative colitis. IBD is a significant and rapidly growing health care burden that affects millions of people around the world and only in the US costs approximately U$6.3 billion/year. There are several therapeutic approaches to induce remission and/or to prevent relapse, however the side effects, toxicity, and lack of response to the existing drugs highlight the need to develop a cure for this devastating disease. The cause of IDB is unknown, however, data suggests that it is caused by the dysregulation of the immune system, and alteration of the intestinal microflora balance. Mesenchymal stromal cells (MSC) have been shown to improve IBD in a small percentage of patients. MSC when infused into patients, migrate directly to inflammatory sites in the body (homing), modulate the inflammatory response and stimulate the resident stem cells. Dr. Almeida-Porada has already shown that increasing the expression of immunomodulatory molecules on MSC leads to better immunosuppression and improvement of IBD in a murine model. Other cells that could help in the treatment of the gut inflammation are endothelial progenitor cells (EPC). These cells are known to increase the vascularization in ischemic tissues, and therefore EPC could help normalize vascularization in the intestinal submucosa of IBD patients.

After I finish the summer program, I will go back to Brazil to pursue my Bachelor's degree in December 2015. This summer research certainly will help me to pursue a PhD degree and become a researcher. In addition, I plan to advise students on how to be a researcher and how to do experiments in the biomedical field, trying to instill the same passion for research in them.

Bryan Chan
Cornell University, Bioengineering

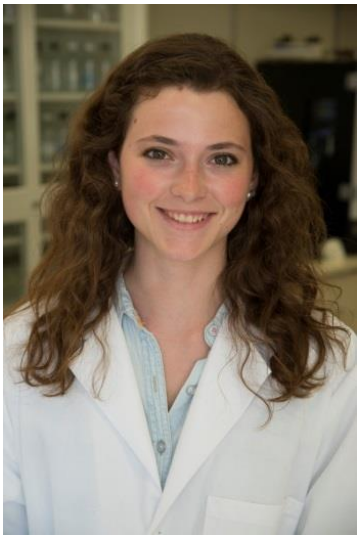
In May, I completed my undergraduate study at Cornell University with a Bachelor's degree in biological engineering and a minor in biomedical engineering. My excitement for the medical field was stimulated last summer during an anatomy laboratory internship at East Tennessee State University's Quillen College of Medicine. Aside from the fascinating cadaver dissections alongside first-year medical students, fellow interns, and professors, my learning experience was complemented by tackling the project of developing a digital medical dissector with my previous academic technology and science writing skills. Filled with new challenges, each day was dynamic and never stale. By the end of the internship, it was impressive how well-versed I was at explaining human systems, and how even this knowledge was miniscule relative to the vast amount of information beyond the curriculum.

During my fourth year at Cornell University, I stumbled upon one of the most influential experiences in my undergraduate career: research at the Reinhart-King Laboratory. The laboratory became much more than what I had imagined. The nature of research is not solely about conducting experiments, but rather a harmonious blend of the curiosity for unveiling the unknown, the excitement for pending experiment results, and the rewarding feeling of successful experiments. To be surrounded by others who are similarly passionate about the field and research of interest is such an amazing work environment – an environment that drew me to the WFIRM Summer Scholars program.

This summer, I will be working under the primary mentorship of Dr. Anthony Atala, along with Dr. Sean Murphy and Amritha Kidiyoor. Under their guidance, I will be focused on characterizing lung stem cells derived from embryonic stem cells to identify novel lung specific transcription factors which could be used to reprogram fibrotic tissue *in vivo* and restore function in pulmonary fibrosis. Since there are currently no effective treatments for this disease, the successful identification of novel targets for the restoration of lung function would be groundbreaking.

In the fall following the WFIRM Summer Scholar program, I will be pursuing a Master in Engineering in Biomedical Engineering at Duke University. I am confident my experience here at the Institute will guide the direction of my career path within my field of interest, and be invaluable in becoming an influential and successful biomedical engineer.

Savannah Est
Washington University, Biomedical Engineering



My name is Savannah Est, and I am a rising Junior in the biomedical engineering program at Washington University in St. Louis. I began research in the field of plant science in high school, but what directed me toward regenerative medicine and organ engineering was a combined passion for engineering science as well as organ donation.

I grew up with an in depth knowledge of the unmet need for organ donation due to some familial health problems, which inspired me to assisted in the foundation of a student group called ORGANize. In partnership with Mid-America Transplant Services, the goal of ORGANize is to promote organ donation advocacy and continued education among not only the scientific community, but the general community as well. Since the foundation of ORGANize, many of my peers have shared their personal experiences with organ donation, and through this sharing, have made me realize that the current shortage of organs is a crisis that not only affects myself, but is currently affecting a significant portion of my own community as well.

This summer at WFIRM, I will be combining this passion for organ donation with my love of biomedical engineering to work on the design and construct of a bioprinted artificial trachea under the primary mentorship of Dr. Anthony Atala along with Dr. Sean Murphy. I will begin by mechanically testing both porcine and human trachea samples to determine the exact specifications the artificial trachea will meet. Next, I will work on designing a functional prototype and finally, design bioreactor to test it.

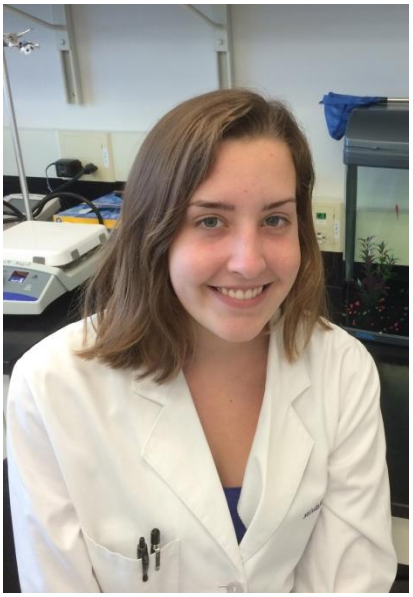
After WFIRM, I plan to finish my undergraduate degree in biomedical engineering and continue to graduate school to pursue either an MD/PhD or a PhD, which will give me the tools and experience I need to apply myself to artificial organ research. Hopefully after graduate school, I will either run a research lab, work for a tissue biofabrication company like Organovo or Organogenesis, or work on a team dedicated to tissue engineering artificial biomaterials.

Sarah Grebennikov
University of Oklahoma, Microbiology

My name is Sarah Grebennikov and I am currently a rising senior at the University of Oklahoma. I am studying Microbiology with a minor in Anthropology in order to combine my two passions: science and humanity. At my own university, I have worked as an Honors Undergraduate Research Assistant under Dr. Masly. His biology lab studies the genetic morphology of damselflies in an effort to further understand the genetic components driving and generating biodiversity. I was originally inspired to apply to the Wake Forest Institute for Regenerative Medicine following the observation of an organ harvest procedure for transplant. Unfortunately, the lungs were no longer viable for transplant following an aggressive extraction of the heart. The future of regenerative medicine has the potential to prevent organ failure and therefore lessen the severe disparity between the number of organ donors and recipients.

As a summer scholar, I will be working with Dr. Tom Shupe. His research is directly involved with the X.C.E.L program, a research initiative to create a body on a chip. At its completion, the project will have a massive impact on the medical community such as essentially eliminating the need for human clinical trials. The microfluidic chip will consist of three-dimensional organoids connected by micrometer channels. In order to fashion the chip to successfully and accurately represent a human body, the interconnected nature of the organs must be incorporated. My focus will be constructing an operative porous membrane plated with endothelial cells in order to represent the blood vessel barrier. This barrier is essential to successfully testing the holistic effects of a drug on all organs of the human body.

I aspire to attend medical school. This program as well as the entire institute is dedicated to providing a transition between the scientific community and clinical medicine. Subsequently, I hope to be involved in regenerative medicine in some capacity in the future.



Samantha Eryn Huddleston
University of Missouri, Bioengineering

I am a bioengineering major and math minor at the University of Missouri, and will be going into my senior year this following fall. I originally began research in Dr. Sheila Grant's biomaterials and biosensors lab, in which I analyzed the cell viability, anti-microbial properties, and strength of porcine diaphragm conjugated with gold and silver nanoparticles. In my second lab, Dr. Andrew McClellan's neurobiology lab, I developed a Matrix Laboratory computer program to determine if there was a change in fluorescence of reticulospinal neurons in the lamprey during calcium imaging. I am engaging in regenerative medicine research because I plan on pursuing a PhD in tissue engineering, and some basis of that field before I get into it is important to me.

I am currently working in the lab of Dr. Frank Marini, who primarily works on cancer research concerning stroma function and structure, and is also known for his imaging skills. I am specifically working on a regenerative medicine project in which I will be analyzing bladder regeneration mice. Normally mice are able to regenerate their bladders to their original shape and function after injury. It is hypothesized in the lab that the macrophage population within the mice plays a big part in this regeneration.

For my future plans, I intend to complete my PhD in tissue or biomedical engineering. After that I will do post-doctoral work, make my way into a government or industrial lab, and eventually end up in academia to perform research.

Michael Hunckler
University of Notre Dame, Mechanical & Bioengineering

I just finished my senior year at the University of Notre Dame in mechanical engineering with a minor in bioengineering. My research experience started back during my junior year in high school, and since then, I have explored so many fascinating projects and research opportunities. My research projects have included work on identifying the exocytosis mechanism of the Ebola virus, development of low-cost detection devices of counterfeit pharmaceuticals in developing countries, investigation into the delivery of cationic contrast agents into damaged collagenous tissues, and studying the biomechanical response of rabbit bones to new osteoporotic medicines.

My love for research and my own personal circumstances have led me to pursue research in regenerative medicine. When I was younger, my little brother was diagnosed with Type 1 diabetes, and I vowed to discover a cure to it when I was older. I took a genuine interest in the disease and followed the current technology that might be able to make his life better. Five years later, I was diagnosed with Type 1 diabetes. My experience with diabetes energized an enthusiasm within me to not only treat this disease, but one day help contribute to finding the cure.

As a WFIRM Summer Scholar, I am privileged to perform research under the direction of Dr. Emmanuel Opara to work on developing a bioartificial pancreas for the treatment and/or cure of Type 1 diabetes. In Type 1 diabetes, the insulin-producing β-cells in the pancreas have been destroyed and the afflicted individual is no longer able to maintain normal glucose levels, which can lead to life-threatening complications. For many years, Dr. Opara and other researchers have attempted to replace these missing β-cells by encapsulating isolated islets in various gel-like materials to protect them

from the immune system before implanting them. However, many limitations have prevented the complete success of their research.

This summer, I am working on optimizing the efficiency of the encapsulation process. The process must be able to create over 1 million perfectly spherical encapsulations in a very short time, while also preventing the death of the cells during the process. I am focusing on optimizing a microfluidic channel design and setup to efficiently generate these encapsulated cells while maintaining cell viability, and monodisperity and structural homogeneity of the capsules.

After my summer at WFIRM, I will finish up my undergraduate degree at Notre Dame in the fall. I am also pursuing a Masters in mechanical engineering with a focus on biomedical engineering at Notre Dame to finish in the spring or summer of 2016. After my Masters, I intend to pursue a clinically-focused Ph.D. program in biomedical engineering. My lifelong mission is to apply myself to the most pressing issues facing human health and improve people's lives through technology and tissue engineering. I hope to ultimately work in an academic medical institution where I can direct research in regenerative medicine while also collaborating directly with physicians to provide the highest quality care to patients.

Blake Johnson
University of Iowa, Human Physiology

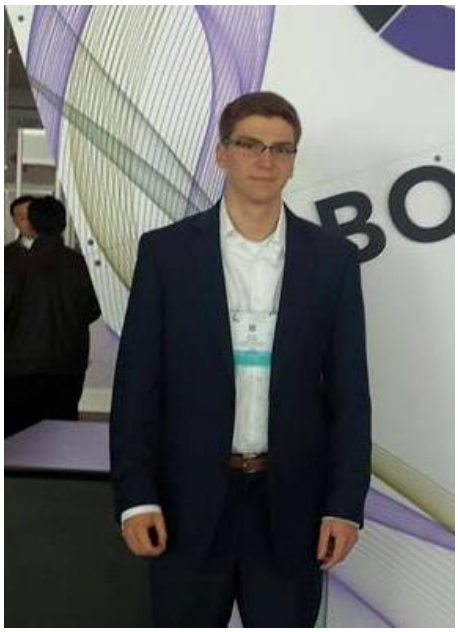
My name is Blake Johnson, and I am a rising senior studying Human Physiology at the University of Iowa. I first became interested in the field of regenerative medicine after viewing Dr. Anthony Atala's TED Talk on his work 3-D printing kidneys. The ability of regenerative medicine to be applied to a vast array of cells, tissues, and organs and the possibility of making patients' truly well again, as opposed to managing symptoms, is inspiring. WFIRM is an outstanding research institution and it is an honor to have been selected to spend the summer learning and growing here.

My previous research under Dr. Janice Staber in the University of Iowa Carver College of Medicine Department of Pediatrics aimed to improve bleeding symptoms in von Willebrand Disease and Hemophilia A patients. von Willebrand Disease (VWD), which results in a prolonged bleeding times following injury due to either qualitative or quantitative deficiencies in von Willebrand Factor (VWF), affects 1% to 3% of the United States, more than any other genetically acquired bleeding disorder. vWD results in decreased FVIII levels due to a lack of protection for FVIII in the plasma. We proposed gene transfer strategies could improve bleeding phenotypes in VWD patients through increased production of VWF, and thus, increased stabilization of the important clotting factor, FVIII.

This summer, I am working under the direction of Dr. John Jackson to generate thymus organoids capable of producing functional T-cells. The thymus serves an important function as the site of T-cell development. Interestingly, as we age the thymus undergoes involution, or decreases in size, leading to a decrease in naïve T-cells. The ability to generate a functional thymus outside the body would have a number of clinical applications including rejuvenation of an aging thymus to boost the immune response in older individuals and development of tolerance in organ transplantation.

I will be using two methods to attempt to generate T-cells outside of the body. 1) I will be seeding decellularized pig thymus with thymus epithelial cells and bone marrow progenitor cells. 2) I will be co-culturing thymus epithelial cells and bone marrow progenitor cells in collagen hydrogels to form small thymic organoids. In the thymus, epithelial cells and progenitor cells work closely together in the development and maturation of T-cells. We hypothesize the interaction between these two cells types is necessary for efficient T-cell production outside the body. In both the decellularized scaffold and hydrogel, I will be using histological techniques to determine if the seeded thymus epithelial cells self-organize into the cortical and medullary regions found in the normal thymus. The regions serve important functions including positive and negative selection of T-cells, respectively. The ability to generate a functional thymus ex vivo has a number of clinical applications and would benefit a large number of patients.

My career goal is to complete an MD and become a surgeon. I hope to continue my work in research and, in particular, regenerative medicine. I am inspired by the work I have seen so far in the field of regenerative medicine, and I believe at some point during my career, regenerative medicine technologies will be used regularly. I hope to also work in the health policy sector.



Ryan Louer
Purdue University, Biochemistry

Growing up in West Milford, New Jersey, I had very limited exposure and opportunities to learn about research first hand. When I attended Purdue University, receiving my B.S. in biochemistry with minors in both French and entrepreneurship, I gained the opportunity to participate in some research for the first time. During my undergraduate studies, my most significant research experience was when I studied and characterized the effects of C-terminal mutations of the Small Ubiquitin-like Modifier (SUMO) protein in *Tetrahymena thermophila*, a single cellular protozoan organism, in Dr. James Forney's lab in the Department of Biochemistry.

SUMO is a conserved protein amongst most eukaryotic organisms, and it regulates many different cellular processes in its attachment to substrates. In humans, deficient attachment of SUMO to substrates has been linked to heart disease and neurodegenerative disorders. The goal of my research was to generate and characterize mutants of SUMO in *Tetrahymena* to find mutants that are unable to attach to substrates, or are unable to be sumoylated themselves, with the hopes of characterizing a novel phenotype or identifying novel substrates. I had found that altering a specific motif of SUMO greatly decreases its stability and ability to be attached to target proteins. When I left this project, all that was left was to characterize a phenotype for some of the mutants. I even had the opportunity to receive a grant from the ASBMB to present my research at the 2015 Experimental Biology conference for this research.

My research experiences sparked a passion for me to continue to pursue different research areas. After looking into a number of possibilities that were available, I found the WFIRM Summer Scholar program would provide an amazing opportunity to do some translational regenerative medical research, a field that had always been of interest to me since I began my undergraduate research.

This summer at WFIRM, I will be working under the primary guidance of Drs. Anthony Atala and James Yoo along with other members of their team including Drs. Myung Jae Jeon and Young Sik Choi studying ovarian cell therapies that will be able to produce natural levels of sex steroids and, hopefully, viable oocytes. So far the lab has developed techniques that allow for theca and granulosa cells, specialized ovarian cells, to produce sex hormones in a morphological dependent manner. Another important feature of this therapy is the ability for hormone production to be controlled by the body's natural feedback mechanisms, providing a much greater control over hormone levels than that of current replacement treatments. The importance of this research is providing effective therapies for hormone and egg replacement that do not have the potential harmful side effects, such as increased risk for heart disease and certain cancers, that current replacement methods pose. Ovarian cell-based therapies can be used in post-menopausal women, women who have had ovarian cancers, and women who have experienced damage to their ovaries from other sources. Ultimately, my career goal is to become a physician, particularly a surgeon. I am pursuing an MD/PhD because of my passion for research. Having the ability to use my skills in a research setting to help people on a much broader scale, in addition to working directly with patients, is the ideal way I want to establish my career in medicine.

Tian McCann
University of Connecticut, Biomedical Engineering

My name is Tian McCann and I am a rising senior at the University of Connecticut where I am pursuing a major in biomedical engineering and a minor in material science engineering. I have always had a passion for engineering and a desire to make an impact on this world for the better. I know; it sounds cliché and overdone, but it's true. I want to be able to make a difference and biomedical engineering allows me to do so while doing what I love. Regenerative medicine specifically has the potential to grow to become an even greater field than it is already and can help more people in the future. I have previously worked in two labs at UConn, aiding with several different projects. For my first project in the Zorlutuna Laboratory, I used microfluidic devices to understand the synchronization and signaling of cardiomyocytes. In the Wei Laboratory, I worked on a fluorescein model with cellular and lamellar bone scaffolds for the eventual purpose of BMP-2 delivery. My most recent project, also conducted in the Wei Laboratory, involved magnetic substitution of hydroxyapatite, focusing on manganese and its characterization.

Here at WFIRM, I am working with Dr. Khalil Bitar and mentors Stephen L. Rego and Elie Zakhem on the neo-innervation of gut tissue. Most enteric nervous system diseases affect inhibitory neurons in the gut and lead to a poor quality of life for the patient. As of now, most treatments focus on bettering the symptoms and not the fixing the underlying cause, which is why regenerative medicine is crucial. Inhibitory neurons are an essential part of the enteric nervous system, as they allow the relaxation of smooth muscle to permit digest contents to pass through the gastric system. Thus, the goal for this project is to understand and improve a way to stimulate inhibitory neuron differentiation. I will be creating ring constructs using smooth muscle cells and innervating them with neural progenitor cells. Each ring will have variable factors so it can be determined which is the optimal method in promoting inhibitory neuron differentiation.

After my time at WFIRM and upon graduating UConn, I plan on attending graduate school to eventually obtain either my master's or PhD in biomedical engineering. Ideally, I aspire to enter industry where I can use creativity and think of new ideas to improve existing techniques or to even form my own. As already aforementioned, my main goal is to help improve the lives of others in any way that I can. I am not sure as to where life will lead me, but I know it will be an exciting journey nonetheless.

Maxwell Marlowe
University of Tennessee, Biology

My name is Max Marlowe. I am a rising senior at the University of Tennessee in Chattanooga majoring in Pre-Professional Biology with a minor in Chemistry. I have been lucky enough to participate in undergraduate research prior to my selection in the program at WFIRM. In the fall of my Junior year, I was selected for a student research assistantship with Dr. Stylianos Chatimanolis, in which we studied sexual dimorphism in a species of Rove beetle. I am currently working with Dr. Ethan Carver on a Departmental Honors thesis investigating differential gene regulation in response to E-Cigarette refill solutions and several major alkaloids found within those solutions. Working on a variety of projects allows me to learn a multitude of techniques, and exposes me to different scientific disciplines with different methodologies.

I became aware of the program, and the field of regenerative medicine, by watching a TED Talk delivered by Dr. Anthony Atala, in which he discussed bioprinting and the fundamentals of Regenerative Medicine. After the talk ended I realized that my jaw had practically been on the floor for the full fifteen minutes of the presentation. I knew then that this was something I wanted to participate in. The science was incredible, on the verge of being science fiction, and the potential

clinical applications seem almost infinite. I personally see regenerative medicine as the future of medicine, and I am overjoyed to be involved in the exploration of this vast frontier.

This summer I have the pleasure of working with Dr. Shay Soker and his graduate student, Matthew Brovold. Congenital biliary disease constitutes a wide array of diseases and is often complicated by fibrosis. Although these diseases are only present between 1:13,000-50,000 births they account for the vast majority of neonatal liver transplants, with biliary atresia constituting more than 50% of fetal liver transplants alone. TGF-ß is a key player in the differentiation of cells in the liver during normal development, and normal cellular function. TGF-ß is produced in a latent state, in which it associates with the extracellular matrix (ECM) using a complex of associated binding proteins. In cases of dysregulation or liver damage TGF-ß has a major role in liver pathology. Inflammation can cause TGF-ß to activate a group of liver cells which produce extracellular matrix (ECM) components, which can become pathological as more of these cells become activated, leading to conditions such as fibrosis, cirrhosis, and potentially cancer.

My project for the summer will investigate the locations and quantity of TGF-ß in the DLM and compare it to human fetal liver tissue. This study will yield insights into the *in vitro* modeling of fetal liver fibrosis.

As for the future, I am currently applying to medical school. I would like to balance a clinical practice while continuing to perform research in the biomedical sciences and regenerative medicine. I would like to do everything I can to benefit the physical and psychological health of my community through a medical practice, and hopefully have a role in research that will aid in increasing the quality of life for future generations.

Natasha Morales
Salem College, Chemistry & Math

I am a rising senior at Salem College here in Winston Salem, NC. I am a chemistry and mathematics double major and statistics and Spanish double minor. My admiration and interest in the work conducted at WFIRM began many years ago. My youngest sister suffered from kidney problems since before she was born and Dr. Atala was actually the doctor who treated her. After this, I began to learn more about the innovation Winston Salem was undergoing regarding biotechnology, particularly at WFIRM, and I feel more than blessed to now be a part of it.

I have conducted research throughout my undergraduate studies. Prior to joining WFIRM, I participated in two summer research fellowships, the first being through Wake Forest University and the second being through the Translational Science Center. My first research project involved synthesizing an inorganic compound, bismuth niobate, via three different methods. Bismuth niobate has been seen as a favorable photocatalyst for reactions such as water splitting, organic conversions, and pollution remediation due to its relatively low bandgap and its ability to absorb in the visible range. After synthesizing the compound by solid state, solution phase, and surfactant-assisted methods, we determined its photocatalytic activity in order to see if the compound's surface area and pore size affected its activity.

The second project involved studying nitroxyl (HNO) because it has shown potential to treat stroke, alcoholism and heart failure. Due to its high reactivity and particularly its dimerization, the use of HNO donors was needed. The focus of the project was to synthesis a nitroxyl –detecting, fluorescent coumarin probe and to compare it to a nitroxyl-detecting, phosphine probe in order to determine which probe detected nitroxyl better. Lastly, I have been working on a biochemistry project involving drug delivery at my home institution.

This summer, I am honored to be working under Dr. Frank Marini. The Marini lab has several ongoing projects, ranging in topics from tumors to imaging and, of course, regenerative medicine. The focus of my project is the functionality of tumors, their triggers and their microenvironments. In order to treat patients with cancer, it is important to know what

the tumor is doing, why and the mechanism that leads to metastasis. It is widely known that cancer cells tend to "hijack" local tissue around it, giving varying amounts of normal, but altered tissue. This makes the identification of the individual steps of the gradation of cancer development all the more important. The overall goal of the project is to ultimately help clinicians improve targeted therapy for cancer patients.
Upon completion of the WFIRM Summer Scholars program, I plan to return to Salem to finish my undergraduate studies. After graduation, I am to continue my education by pursuing a PhD in chemical engineering. I yearn to be involved in future research projects with a chemistry and biochemistry focus and to become a professor in order to share my love for the sciences with others.

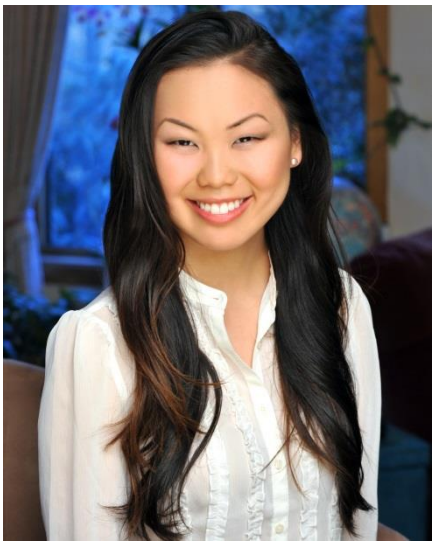
Tracey Pu
Wake Forest University, Biology B.S. and Studio Art

I am a rising senior at Wake Forest University, double majoring in biology and studio art. Although most people think this is a peculiar combination, I believe science and art intertwine intimately in both philosophy and methodology. An artist must respond a changing medium with precision, altering technique based upon preceding actions. Much like artists, scientists must also adapt quickly in the regenerative medicine field due to its complex novelty. Modern techniques change daily, and the knowledge base increases every day. Thus, to be fully prepared in the field of research, I try to take advantage of every opportunity to expand my knowledge not only in the scientific realm, but also in other areas. I love to travel, and in the past two years, I have travelled to over 25 cities in 14 countries. I am fascinated with the universality of the language of medicine and how it transcends geographical and cultural barriers, similar to art.

A fundamental problem of tissue engineering today is the integration of a functional vasculature network that can provide sufficient oxygen supply. This limits the size of regenerating organs or healing large wounds completely. Since late 2012, I have worked with Dr. Benjamin S. Harrison's team studying the oxygen generation profiles of polymeric oxygen generating species (POGs). In Fall 2014 to Spring 2015, I designed an experiment to examine the effects of select antioxidants on the oxygen generation profile of sodium percarbonate (SPO).

During this summer, I will continue research under the guidance of Dr. Benjamin S. Harrison and Dr. Tracy L. Criswell researching how POGs will affect the angiogenic factors of cells under hypoxic stress. Ultimately, the goal is to use POG materials to sustain cell viability short term while allowing angiogenic signaling to promote long-term survival after the depletion of oxygen from POG materials. My project will assess the hypoxic and angiogenic response of cells and tissues receiving various physiologically relevant levels of oxygen supplied by POG materials. Our angiogenesis research may be a potential solution to the oxygen supply problem in both tissue engineering and wound healing.

In the fall, I hope to continue research in both the Harrison Lab at WFIRM and at the Bonin/Guthold Lab at WFU Reynolda Campus. I will graduate in Spring 2016 with the hopes to attend medical school and ultimately become a physician.



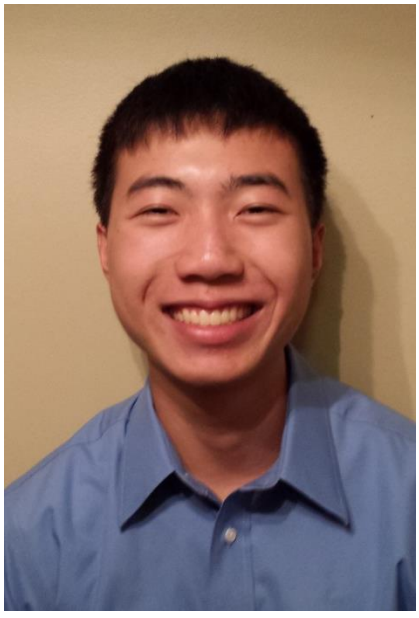
Ivy Shen
Dartmouth College, Neuroscience

I am a rising senior at Dartmouth College, and I am pursuing a neuroscience major with a minor in Global Health. I keep busy as the president of Relay for Life, Colleges against Cancer, and Students Fighting Hunger. In my spare time I enjoy playing the violin in the Dartmouth Symphony Orchestra and competing for the Club Tennis team. In my off terms, I learned classical French cooking and worked as a Tucker Foundation Fellow at Boston Healthcare for the Homeless. At the Neurological Rehabilitation Unit of Rhode Island I conducted a study on improving neurological signals and was published in the Northeast Biomedical Conference. At Dartmouth College I enjoy research in a neuroengineering lab that studies mechanisms of childhood obesity.

This summer I will be a part of Dr. Frank Marini's team at the Comprehensive Cancer Center. As a summer scholar, I will study tumor microenvironments as well as tissue and wound repair and regeneration. Dr. Marini and his team study tumor stroma interaction s at the cellular level. One sub projects focuses on the interactions of mesenchymal stem cells and their interaction and transition into tumor-associated fibroblasts, one of the most prevalent non-cancerous cell type found in tumors. TAFs have been clinical associated with poor prognosis and clinical outcome in cancer patients. Dr. Marini and others have shown that TAFS support tumors through a variety of mechanisms, such as rapid vascularization, production of tumor-supportive cyto/chemokines, up regulation of tissue digesting proteins, etc. Given this, the lab studies the generation of TAFS from MSC, and has cataloged the various subtypes of TAFS and demonstrated the benign to aggressive phenotypes, but importantly, studying why and how TAFS support tumors and why TAFs up regulate the tumor microenvironment to be more aggressive. We do this through various cell biological studies in vitro and in vivo and utilize a number of sophisticated –omit discovery platforms, as well as devolving deeply into the transcriptional regulation of TAFs. The second prong of the attack is through the use of sophisticated imaging modalities in which we can visualize these interactions. Additional projects involves complex image analysis, and confocal, multi photon, and multispectral microscopy.

After graduation, I plan to go to medical school to become a neurosurgeon and study neurodegenerative diseases. As a future physician, I hope to treat patients with compassion and insight of clinical aspects with the skills I have developed through research.

Brian Shing
University of California, Berkeley, Molecular & Cellular Biology



I am a rising junior at the University of California, Berkeley and intend to major in Molecular and Cell Biology. My first research experience was as an intern for BNNI-SHARP (Berkeley Nanosciences and Nanoengineering Institute Summer High School Apprenticeship Program) at UC Berkeley. As an intern at Zettl lab, I worked under the guidance of Ashley Gibb. I synthesized graphene, a monolayer of carbon atoms, to create an enclosure that could be filled with a solution of biomolecules. This enclosure would allow nanometer resolution imaging of biomolecules under hydrated conditions using transmission electron microscopy (TEM), a microscope that transmits electrons through a sample for imaging. This project aimed to use nanotechnology and materials science to improve existing microscopy capabilities for researchers, and it is still an ongoing field of research.

I am currently a research member of NanoNerve, Inc. and the Li lab at UC Berkeley. NanoNerve is a biotechnology start-up specializing in neural

regeneration that has developed a synthetic graft to aid nerve regeneration. I work primarily under the guidance of Dr. Shyam Patel. I culture pluripotent stem cells and characterize the graft's efficiency in differentiating the stem cells into neuronal stem cell lineages. I characterize the differentiation by employing histological techniques to stain the cells for imaging. Next semester, I intend to continue researching this ongoing endeavor to develop a product that can regenerate nerves in patients with peripheral nerve damage.

This summer at the Wake Forest Institute of Regenerative Medicine, I will be working with Drs. In Kap Ko, James J. Yoo and Anthony Atala's team on the kidney regeneration project. Kidney disease is a leading cause of death in the United States [1]. Three major forms of kidney disease are acute kidney injury (AKI), chronic kidney disease (CKD), and end stage renal disease (ESRD). AKI and CKD are conditions where the kidney loses its ability to function and filter blood efficiently [2]. AKI can often worsen into CKD, which affects 8 -16% of the population globally [3]. Further degradation of renal function can lead to ESRD, a life-threatening condition where the kidney completely fails.

Current medical therapies for renal disease primarily revolve around hemodialysis or kidney transplantation. Both of these treatments have inherent limitations. Dialysis can replace the kidney in filtering metabolic waste from blood, but it is merely a supportive treatment that only manages symptoms and slows disease progression. Dialysis also cannot replace other critical renal functions, such as synthesizing erythropoietin hormone to stimulate red blood cell production [4]. Consequently, treatment of renal disease should promote efficient regeneration of functional renal-specific cells. Cell-based approaches that can replace or restore damaged renal cells may provide an excellent alternative to current treatments.

Recent advances in stem cell biology and cell culture techniques have facilitated the development of cell therapy for preclinical and clinical translation [5, 6]. Particularly, recent studies have reported that secretome, such as growth factors, derived from therapeutic cells could enhance regeneration of damaged tissues [7]. WFIRM has recently tested the feasibility of using secretome from therapeutic stem cells for the treatment of kidney diseases. This summer, I will be working with the WFIRM team to explore a novel delivery system that allows for efficient delivery of the secretome secreted from human placental stem cells (hPSCs) and evaluate the secretome's effect on renal regeneration.

I am excited for this project because the use of stem cells in regenerative medicine could hold the key to treating many currently untreatable diseases and conditions. Science-based solutions to disease are possible and can significantly improve the lives of people throughout the world. Making the world a better place is a worthwhile goal. After I have finished my education, I would like to work in the biotechnology industry. I am also interested in exploring the possibility of conducting biomedical research as a military researcher.

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[3] Jha, Vivekanand, et al. "Chronic kidney disease: global dimension and perspectives." *The Lancet* 382 (9888) : 260-272 (2013).
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[5] Eirin A, Lerman LO. Mesenchymal stem cell treatment for chronic renal failure. Stem cell research & therapy 2014;5:83.
[6] Rosenberg ME. Cell-based therapies in kidney disease. Kidney international supplements 2013;3:364-67.
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Samantha Austin Starr

George Washington University, Biomedical Engineering

My name is Samantha Starr and I am a rising senior majoring in biomedical engineering at the George Washington University. I have a passion for engineering and medicine pushing me to pursue engineering as an undergraduate followed by medical school. My interest in regenerative medicine and the creation of sustainable engineered organs comes from my family's experience with organ failure, organ donation, and failure of the donated organ. I want to eliminate the need for organ donor lists and long wait times and lower the chances of organ rejection after transplant. Before coming to WFIRM, I completed cardiac research in Dr. Jonathan Silva's lab at Washington University in St. Louis.

While at WFIRM, I will be working with Dr. Heng-Jie Cheng. My project consists of three main goals. The first goal is to isolate, culture, and characterize left ventricular cardiomyocytes from neonatal rats. The cells will then be used in bioprinting scaffolds where they will grow, proliferate, and differentiate. Second, I will isolate, culture, and characterize left ventricular cardiomyocytes from adult rats. The cells will then be used as tools for evaluation and selection of stem cell produced myocytes that are as mature as possible. Lastly, I will do work in the Cardiovascular Research Center, specifically in cardiomyocyte functional evaluation and cardiac hemodynamic evaluation.

After graduating, I plan to attend medical school at the George Washington University School of Medicine and Health Sciences. As a doctor, I plan to continue research in regenerative medicine. I hope to combine my engineering and medical skills to help bring my patients the best possible care.